

List of Claims

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- 21
1. (cancelled) A fuel injector nozzle insert comprising:  
a metallic body having a first end separated from a second end by a circumferential side surface, at least one nozzle outlet that opens through said first end, and at least one passage opening through said second end;  
a portion of said at least one passage being an annular valve seat on said metallic body;  
said circumferential side surface including an annular valve surface positioned between a first cylindrical surface and a second cylindrical surface.
  2. (cancelled) The nozzle insert of claim 1 wherein said side surface includes a planar tube abutment surface adjacent and perpendicular to said second cylindrical surface.
  3. (cancelled) The nozzle insert of claim 1 wherein said annular valve surface includes a frustoconical portion.
  4. (cancelled) The nozzle insert of claim 1 wherein said first cylindrical surface has a guide length and a guide diameter that is smaller than said guide length.
  5. (cancelled) The nozzle insert of claim 1 wherein said second cylindrical surface has a mating length and a mating diameter that is smaller than said mating length.

6. (cancelled) The nozzle insert of claim 1 wherein said at least one nozzle outlet includes a plurality of nozzle outlets that are oriented into at least one of a non-impinging spray pattern and an impinging spray pattern.

7. (cancelled) The nozzle insert of claim 6 wherein said circumferential side surface includes a planar tube abutment surface adjacent and perpendicular to said second cylindrical surface;

said first cylindrical surface has a guide length and a guide diameter that is smaller than said guide length; and

said second cylindrical surface has a mating length and a mating diameter that is smaller than said mating length.

8. (original) A needle valve member for a fuel injector comprising:  
a nozzle insert having an external valve surface, an internal valve seat and at least one nozzle outlet;

a tube irreversibly attached to said nozzle insert.

9. (original) The needle valve member of claim 8 wherein said nozzle insert includes one of a cylindrical male mating surface and a cylindrical female mating surface; and

said tube having an other of said cylindrical male mating surface and said cylindrical female mating surface mated to said nozzle insert.

10. (original) The needle valve member of claim 8 wherein said tube includes an external surface with a first diameter adjacent said nozzle insert and a second diameter away from said nozzle insert; and

said first diameter is smaller than said second diameter.

11. (original) The needle valve member of claim 8 wherein said at least one nozzle outlet includes a plurality of nozzle outlets that are oriented into at least one of a non-impinging spray pattern and an impinging spray pattern.

12. (original) The needle valve member of claim 8 wherein said nozzle insert has a circumferential side surface that includes said external valve surface positioned between a guide cylindrical surface and a mating cylindrical surface.

13. (original) The needle valve member of claim 12 wherein said guide cylindrical surface has a guide length and a guide diameter that is smaller than said guide length.

14. (original) The needle valve member of claim 12 wherein said mating cylindrical surface has a mating length and a mating diameter that is smaller than said mating length.

15. (original) The needle valve member of claim 8 wherein said tube includes an external surface with a first diameter adjacent said nozzle insert and a second diameter away from said nozzle insert, and said first diameter is smaller than said second diameter;

said at least one nozzle outlet includes a plurality of nozzle outlets that are oriented into at least one of a non-impinging spray pattern and an impinging spray pattern.

16. (original) The needle valve member of claim 15 wherein said nozzle insert has a circumferential side surface that includes said external valve surface positioned between a guide cylindrical surface and a mating cylindrical surface;

said guide cylindrical surface has a guide length and a guide diameter that is smaller than said guide length; and

said mating cylindrical surface has a mating length and a mating diameter that is smaller than said mating length.

17. (cancelled) A method of making a needle valve member for a fuel injector, comprising the steps of:

forming a nozzle insert to include an annular valve seat and an annular valve surface;


machining at least one nozzle outlet through an end of said nozzle insert; and

irreversibly attaching said nozzle insert to a tube.

18. (cancelled) The method of claim 17 wherein said forming step includes a step of shaping the nozzle insert to include a cylindrical mating surface and a cylindrical guiding surface that share a common centerline with said annular valve surface and said annular valve seat.

19. (cancelled) The method of claim 17 wherein said at least one nozzle outlet includes a plurality of nozzle outlets; and

said machining step includes a step of orienting said plurality of nozzle outlets to have at least one of a non-impinging spray pattern and an impinging spray pattern.

 20. (cancelled) The method of claim 17 wherein said irreversibly attaching step includes the steps of:


press fitting a male cylindrical surface on said nozzle insert into a female cylindrical surface in said tube; and  
welding said nozzle insert to said tube.

21. (new) A fuel injector comprising:  
an injector body; and  
the needle valve member of claim 8 at least partially positioned in said injector body.

22. (new) The fuel injector of claim 21 wherein said nozzle insert includes one of a cylindrical male mating surface and a cylindrical female mating surface; and  
said tube having an other of said cylindrical male mating surface and said cylindrical female mating surface mated to said nozzle insert.

23. (new) The fuel injector of claim 21 wherein said tube includes an external surface with a first diameter adjacent said nozzle insert and a second diameter away from said nozzle insert; and  
said first diameter is smaller than said second diameter.

24. (new) The fuel injector of claim 21 wherein said at least one nozzle outlet includes a plurality of nozzle outlets that are oriented into at least one of a non-impinging spray pattern and an impinging spray pattern.



25. (new) The fuel injector of claim 21 wherein said nozzle insert has a circumferential side surface that includes said external valve surface positioned between a guide cylindrical surface and a mating cylindrical surface.

26. (new) The fuel injector of claim 25 wherein said guide cylindrical surface has a guide length and a guide diameter that is smaller than said guide length.

27. (new) The fuel injector of claim 25 wherein said mating cylindrical surface has a mating length and a mating diameter that is smaller than said mating length.

28.(new) The fuel injector of claim 21 wherein said tube includes an external surface with a first diameter adjacent said nozzle insert and a second diameter away from said nozzle insert, and said first diameter is smaller than said second diameter;  
said at least one nozzle outlet includes a plurality of nozzle outlets that are oriented into at least one of a non-impinging spray pattern and an impinging spray pattern.

29. (new) The fuel injector of claim 28 wherein said nozzle insert has a circumferential side surface that includes said external valve surface positioned between a guide cylindrical surface and a mating cylindrical surface;

said guide cylindrical surface has a guide length and a guide diameter that is smaller than said guide length; and

said mating cylindrical surface has a mating length and a mating diameter that is smaller than said mating length.

30. (new) The fuel injector of claim 21 wherein said at least one nozzle outlet has a first spray pattern; and

said injector body defining at least one additional nozzle outlet that has a different spray pattern.

31. (new) The fuel injector of claim 21 wherein said at least one nozzle outlet is at least one homogeneous charge outlet; and

said at least one additional nozzle outlet is at least one conventional nozzle outlet.

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